

CO₂ Emissions Reduction Target and Reporting Protocol

Sustainable Silicon Valley

Background

Introduction:

The California Environmental Protection Agency, the Silicon Valley Manufacturing Group, the Silicon Valley Environmental Partnership and other governmental, educational and community organizations, formed the Sustainable Silicon Valley initiative in 2001 to explore the possibility of improved regional environmental performance without ‘command and control’ regulations. The group used the model of an Environmental Management System to identify opportunities and priorities for action.

Renewable and other energy use, energy efficiency, and the resulting CO₂ emissions, were chosen by the group as a key action opportunity, because:

- Many Silicon Valley organizations had demonstrated significant energy savings, in part resulting from the recent energy crisis, resulting in cost savings and environmental performance improvements.
- Other regions and organizations (Sonoma County, the City of Toronto, various Silicon Valley businesses) had already ‘signed up’ to specific CO₂ emissions reductions goals. The goal selected by the group was consistent with other existing regional emissions reduction goals and represents a stretch goal for the region.
- Reducing energy intensity (energy used per unit output) across the commercial, residential and transportation sectors was seen as having multiple benefits, including (but not limited to): opportunities for cost savings, success through broad participation and collaboration, reduction of the environmental impact of the region, and the demonstration of a leadership role on an issue of growing policy and economic significance.

On April 24, 2003 Sustainable Silicon Valley (SSV)¹ announced that it has adopted a goal to reduce carbon dioxide (CO₂) emissions in the Silicon Valley region by 20 percent by 2010, using 1990 as a base year.² The group recognized the challenge of such an ambitious goal. At the same time, the group expressed the desire to aim high, and thus encourage creative, collaborative and motivated participation by as wide a group of organizations as possible, highlighting Silicon Valley’s leadership and innovation on this issue.

What’s in it for You to Participate?

- **Save Money.** By improving your energy efficiency (and thereby reducing your CO₂ emissions), you will save money. That will go directly and completely to your bottom line.
- **Recognition.** Your organization will be publicly recognized for its efforts and achievements. This is a unique PR opportunity to enhance your reputation as a leader and can help respond to increasing requests from customers and the socially responsible investment community.³ SSV is already garnishing interest from high-level government officials for this innovative regional approach.

- **Leadership and Innovation.** Silicon Valley is regarded as a birthplace of innovation. This partnership is a testament to that. The results of your individual energy efficiency (or other innovative) program will be combined with that of other organizations. The cumulative impact will be much greater, and demonstrate how Silicon Valley organizations are collaborating to reduce CO₂ emissions.. Many see some type of CO₂ emissions reduction regulations or trading mechanism as inevitable. By participating in this voluntary, innovative, and collaborative effort, your organization will be setting the “rules of the game” for carbon dioxide emission reductions in the United States. This effort serves as an incubator for new technologies and business models. In addition, it helps retain current businesses and attract top talent to one of the most beautiful places in the world.
- **Partnership and Collaboration.** Energy savings projects hinge on two criteria – technological advances and cost savings. By partnering with the SSV, organizations will have access to the best practices and business cases used by all participants in developing their programs. In addition, information on methodologies to document the cost savings, energy savings, and CO₂ reductions will be provided. The International Council for Local Environmental Initiatives (ICLEI) has software available to participants to help with data collection and quantification. ICLEI offers a variety of technical assistance and training through its technical assistance fee structure.

Why adopt an energy use goal based on carbon dioxide emissions?

As SSV was developing a target for the energy aspect of this management system, the organizing committee agreed that renewable energy should not be viewed in isolation. Before embarking on major efforts to increase the use of renewable energy, an organization or region must be assured that it is using energy efficiently. Therefore, the SSV organizing committee expanded the focus from renewable energy to energy use, both its efficient use and the increased emphasis on renewable energy technologies.

Energy usage is measured by a variety of units, including kilowatt hours (kWh) of electricity, therms of natural gas, gallons of petroleum-derived fuels (such as gasoline or diesel), and tons of coal.

From an environmental perspective, both the amount and environmental impact of energy use are important. The carbon content of fossil fuels⁴ can be used as a proxy for the relative environmental impacts of their combustion. While some emissions occur naturally when a fuel is burned and can be cleaned or “scrubbed” (e.g., nitrogen oxide and oxides of sulfur), the carbon in these fuels cannot, and is released, most often as CO₂. In addition to serving as a proxy for the relative cleanliness of different fossil fuels, the carbon compounds released when they are burned (most significantly CO₂) have been implicated as major contributors to global climate change.

CO₂ emissions in Silicon Valley can therefore be viewed as representative of both energy efficiency (the amount of energy used per unit output) and energy effectiveness (the relative carbon intensity of fuels or the amount of renewable energy used).

In 1990, 13.42 million tons of CO₂ were emitted into the atmosphere in Silicon Valley.⁵ The SSV goal of a 20% reduction on a regional basis means that no more than 10.74 million tons of CO₂ should be emitted in 2010.⁶ This CO₂ emission reduction goal for Silicon Valley is measured in absolute values and is not normalized by economic factors such as gross regional

product. However, goals for participants in this SSV initiative can be normalized for economic activity including, but not limited to, sales, number of employees or square footage.

Won't increases in economic activity automatically increase energy use and carbon dioxide emissions?

In modern industrial societies economic activity requires the use of energy, most commonly fossil fuels. Therefore, goals related to energy use (or CO₂ emissions in this case) are often normalized for economic activity, population, or some other variable. Some nations express concern with their international competitive advantage if energy/emissions goals are not normalized, citing the commonly accepted (though less so recently)⁷ one-to-one correlation of economic growth and energy use as the necessary price for continuing economic prosperity.

Regional emissions of greenhouse gases can vary significantly based on economic cycles. As the economy booms, commercial and industrial activity increases, vacancy rates drop, and more energy is used. All else being equal, carbon dioxide emissions also reflect these changes in the use of energy. As the Silicon Valley economy and population grew in the 1990s for example, emissions of CO₂ increased, reaching 15.7 million tons in 2000. One can contrast this with the reduction in emissions in the 1991-1993 timeframe, during the last recession in Silicon Valley (see Table 1).

Table 1: Estimated CO₂ Emissions in Silicon Valley 1990 --2000⁸

Base Year	CO ₂ emissions (thousand tons)
1990	13,421
1991	13,189
1992	13,273
1993	12,814
1994	14,221
1995	12,269
1996	12,454
1997	13,525
1998	14,097
1999	15,627
2000	15,699

However, from a global environmental perspective, economic normalization of an energy/CO₂ goal makes less sense. Human activities are releasing CO₂ and other greenhouse gases⁹ into the atmosphere at a rate greater than the global ecosystem can assimilate them. Absolute, not economically normalized, reductions of emissions of CO₂ and other greenhouse gases must occur to mitigate the greenhouse gas emissions implicated in global climate change. (SSV recognizes that there are several greenhouse gases, but for the purposes of this SSV goal for energy, only CO₂ is considered.)

An absolute goal won't work for my organization. How else can I participate?

Project participants can select economically normalized CO₂ emission reduction goals. SSV recognizes the arguments for normalizing an energy/CO₂ emissions goal and accepts the

environmental importance of an absolute goal. SSV also acknowledges Silicon Valley's global innovation leadership and the extent of its influence in the nation and the world. Therefore, SSV adopted an absolute CO₂ emission reduction goal for the region but provides project participants the flexibility to adopt normalized CO₂ emission reduction goals. SSV recognizes that it is through the efforts of its formal and informal partners and participants, and not of SSV itself, that its CO₂ emission reduction goal will be met. Therefore, ensuring flexibility in setting emissions reduction goals, such as utilizing economically based normalization of CO₂ emissions, is critical to a successful voluntary CO₂ reduction partnership. The SSV also anticipates working with participating organizations to identify and implement innovative and cost effective emissions reductions strategies.

What if my organization is already participating in a reporting protocol –or – What if my organization doesn't have the resources to do a lot of detailed data management?

The protocol adopted by SSV for the accounting and reporting of CO₂ emissions allows participating organizations to choose to normalize using the factor of their choice, such as sales, number of employees, or square footage of the participating facility. Flexibility is also built into the base year. Any year after 1989 can be used. If an organization is already a participant in other programs, such as those listed below, it may already have information applicable to this SSV initiative. Additionally, the reporting protocol is intended to be as simple as possible to ensure ease of use by a wide variety of organizations.

- The General Reporting Protocol of the California Climate Registry (<http://www.climateregistry.org>)¹⁰
- The International Council Local Environmental Initiatives: Cities for Climate Protection Program (<http://www.iclei.org/>).
- The World Business Council on Sustainable Development/World Resources Institute's *The Greenhouse Gas Protocol: a corporate accounting and reporting standard* (<http://www.ghgprotocol.org/standard/ghg.pdf>)

Participating organizations may choose to submit their report for any of these other efforts as its report for the SSV. Finally, if an organization chooses to participate in one of these programs in the future, it will already have some of the information necessary for those reporting purposes.

By designing its flexible reporting requirements in a manner that is compatible with the requirements of other greenhouse emissions reporting protocols, SSV intends to minimize duplicative efforts.

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Reporting Protocol

Summary of the SSV Protocol for Measuring and Reporting CO₂ emissions

Table 2 summarizes the steps for participating in the SSV CO₂ Emissions Reduction Project.

Table 2: Steps for Participants in the SSV CO₂ Emissions Reduction Project

A participating organization will:

1. Choose one (or more) of its facilities in Silicon Valley;
2. Select a baseline reporting year for each facility;
3. Track each facility's annual electricity and natural gas use;
4. Adopt a goal for CO₂ emissions reduction (percentage and year),
5. Report annually to SSV (either annual energy use or convert total energy use (kWh, therms, gallons) into CO₂, to determine total annual emissions). If the participant chooses to use a normalizing factor, that factor should also be reported annually.
6. Include a brief description (one-two paragraphs) of some (two-five) of the key actions it has taken that led to the decreasing emissions of CO₂.

In addition, organizations may:

1. Select a normalizing factor for each facility;
2. Track its diesel and/or gasoline use for its fleet, employee business use of personal vehicles, and/or employee commuting;

This is a voluntary project; there are no sanctions for a participant failing to meet its goal.

How will my organization be recognized for its achievements?

SSV will release a report annually, documenting CO₂ emissions in the region and compare it to the 2010 goal. Publication of this report will most likely be via the worldwide web. Included in the SSV annual report will be:

- A list of all project participants,
- Highlights of the organizations achieving the most substantial CO₂ emissions reductions in the previous reporting period and since their base years,
- Highlights of the actions taken by project participants that led to the decreasing emissions of CO₂, and
- Beginning in 2005, the organizations matching or exceeding the Valley goal of 20% CO₂ reductions on an absolute or normalized basis and highlights of their efforts.

At a participant's request, the SSV can provide shareholders or customers with documentation of an organization's participation in this regional goal as part of demonstrating their Environmental Stewardship or Corporate Social Responsibility programs.

Who may participate?

All organizations in Silicon Valley (which for this purpose includes the counties of Santa Clara, San Mateo and Alameda) are invited and encouraged to participate. This includes all sizes and types of businesses, governmental, educational, and non-governmental organizations and associations.

To be listed as a project participant in the SSV annual report, an organization must complete the six steps in Table 2 above and submit a report, which demonstrates a reduction in CO₂ emissions.

Participants that meet or exceed the Silicon Valley regional goal of 20 percent reduction in its CO₂ emissions will be listed and have specific highlights in the annual report.

Detailed Information

On the Measuring and Reporting of CO₂ emissions

Physical site: While the intent is to provide for a broad level of participation, an organization may choose any facility in Silicon Valley for inclusion in this effort. If an organization has two physically independent facilities in Silicon Valley, e.g., in different parts of the Valley, either or both can be included. However, an entire physically-dependent facility must be included. The general rule is that multiple buildings/facilities at a single physical site that share electric and natural gas meters must be included.

Examples: The entire administration building must be included in the program rather than one or several departments in the building. An entire manufacturing site must be included, rather than just the warehouse building unless the warehouse is physically independent from the manufacturing facility, i.e., located in a different place and with its own electric and natural gas meters.

Energy use measured: Ideally, all of the major uses of fossil-based energy in Silicon Valley, i.e., electricity, natural gas, diesel and gasoline, would be measured. At a minimum, annual electricity and natural gas usage will be tracked over time. Information readily available from a participant's electricity and natural gas bills will suffice for these measurement purposes.

Gasoline and diesel fuel usage is more difficult to measure. A participant may choose not to include the gasoline and diesel fuel usage at all. (However, the participant may lose significant potential for emissions reduction since gasoline accounts for more than half of the CO₂ emissions in the Valley. Additionally, the California Climate Action Registry requires inclusion of fleet vehicles)

Alternatively, a participant may choose to include only its fleet's use of gasoline and diesel fuel. Presumably the participant would have a record of gasoline and diesel fuel usage by its fleet. Or, a participant may choose to include an estimate of its employees' use of gasoline for commuting and company business. Measurement of employee use of gasoline can be determined by the participant, but the measurement protocol must be consistent over time.¹¹ Whichever energy use is being reported by an organization, the measures should be consistent over time.

Energy Use and Carbon Dioxide Emissions to be Reported: A participant may report either its annual energy use in kWh of electricity, therms of natural gas and (if included in the participant's measurements) gallons of gasoline and diesel fuel. Alternatively, the participant may convert these energy measures into the carbon dioxide emissions that results in the use of the energy (see Table 3).

Table 3: Fossil Fuel Use → Carbon Conversion factors:

Fuel	Carbon (C) Conversion Factor & Source	Geographically-Based Participants (city, county)	Facility-Based Participants (company, NGO, government use)
Natural gas	3.174 lbs C/therm or 11.64 lbs CO ₂ per therm (EPA Workbook 1995)	Annual natural gas sales (therms) within the city or county multiplied by 11.64 lbs CO ₂ per therm divided by 2000 lbs/ton.	Annual natural gas sales to the facility multiplied by 11.64 lbs CO ₂ per therm divided by 2000 lbs/ton.
Gasoline	5.30 lbs C/gallon or 19.43 lbs CO ₂ per gallon (EPA Workbook 1995)	Annual gasoline sales (gallons) within the city or county (from Board of Equalization) multiplied by 19.43 lbs CO ₂ per gallon divided by 2000 lbs/ton.	Annual gasoline usage by facility fleet (gallons) multiplied by 19.43 lbs CO ₂ per gallon divided by 2000 lbs/ton. Fleet usage determined by sales invoices. Employee commute mileage (if measured) to be determined by participant.
Diesel	5.74 lbs C/gallon or 21.05 lbs CO ₂ per gallon ¹²	Annual diesel sales (gallons) within the city or county multiplied by 21.05 lbs CO ₂ per gallon divided by 2000 lbs/ton.	Annual diesel usage by facility fleet (gallons) multiplied by 21.05 lbs CO ₂ per gallon divided by 2000 lbs/ton. Fleet usage determined by sales invoices.
Electricity	Annual PG&E-specific electric generation portfolio determines weighted average lbs CO ₂ per kWh sold in Santa Clara County (from CEC and SVEP)	Annual electricity sales (kWh) within the city or county multiplied by appropriate factor divided by 2000 lbs/ton.	Annual electricity sales (kWh) within the facility multiplied by appropriate factor divided by 2000 lbs/ton.

Base year: The participant that strives to be highlighted as having adopted a CO₂ emissions reduction goal that meets or exceeds the Silicon Valley regional goal of 20 percent may select as a base year any year after 1989. Since the SSV goal is to reduce CO₂ emissions in 2010 to a level 20 percent below the 1990 level, the CO₂ emissions in the base year chosen determines the participant's goal for 2010. Table 4 depicts the goal for each base year chosen.

Table 4: Estimated CO₂ Emissions in Silicon Valley and Goal for Each Base Year

Base Year	CO ₂ emissions (thousand tons)	Goal for 2010
1990	13,421.09	20.00%
1991	13,189.47	19.60%
1992	13,273.66	19.11%
1993	12,814.20	16.21%
1994	14,221.01	25.50%
1995	12,269.84	12.49%
1996	12,454.71	14.79%
1997	13,525.13	21.06%
1998	14,097.90	24.84%
1999	15,627.30	31.29%
2000	15,699.37	32.61%

Normalization of CO₂ emissions: Each participant may choose to adopt an absolute or normalized goal and determines which (if any) normalization factor is to be used. Among the more commonly used normalization factors are sales, number of employees, square footage of facilities, and number of vehicles in a fleet.

A participant that strives to be highlighted as having adopted a CO₂ emissions reduction goal that meets or exceeds the Silicon Valley regional goal of 20 percent choosing 1993 as a base year and an absolute goal would commit to reducing its CO₂ emissions in 2010 by 16.21 percent. A participant choosing 1993 as a base year and a goal normalized for sales would commit to reducing its CO₂ emissions per unit of sales in 2010 by 16.21 percent.

Frequency of reporting: Each participant should report annually to the SSV administrator three months after the end of the participant's fiscal year (or the calendar year). This report should be sent electronically to the SSV administrator (address TBD).

Content of Report: To enable effective tracking, the participant's report should include:

1. Name of the organization;
2. Address of the participating facility(ies);
3. Standard Industrial Classification (SIC) Code of the participating facility(ies);
4. Contact information, i.e., name, address, telephone, and email, for the key person gathering the data;
5. Energy sources being tracked, e.g., natural gas, electricity, gasoline, diesel;
6. Base year adopted and CO₂ emissions reduction goal;
7. Normalization factor (if any);
8. Energy use tracked annually since the base year and through the most current year (this information can be provided in units of energy or CO₂ emissions as described above).
9. Comparison of energy use (or CO₂ emissions) reported for the current year to the base year.
10. A short narrative of activities/programs undertaken or planned to meet the 2010 target. (This information will likely be shared with others as "best practices" and included in SSV's annual reports).

To the extent a participant gets better data after submitting its annual report to SSV, for example more accurate or comprehensive data or data certified by a third party, it should submit the improved data.

¹ Sustainable Silicon Valley (SSV) is a multi-stakeholder collaborative initiative that includes representatives from business, the environmental community and government whose aim is to improve environmental management and resource conservation in the Silicon Valley through the creation of a Silicon Valley Environmental Management System (EMS). The partners in SSV are the Silicon Valley Manufacturing Group, California Environmental Protection Agency and Silicon Valley Environmental Partnership. Through a multi-stakeholder collaborative process SSV has established a set of environmental indicators that will be the basis for the EMS. Energy and water usage have been identified as the first two significant environmental issues to be addressed by the SSV initiative through a regional environmental management system. The energy use target is the first established by SSV.

The geographic boundaries of Silicon Valley include the area approximately bounded by the City of South San Francisco in the north, by Scotts Valley in Santa Cruz County and Morgan Hill in Santa Clara County in the south, and by the Coastal Range hills west and east of the San Francisco Bay.

² The Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol) calls for the United States to reduce its greenhouse gas (GHG) emissions by seven percent in the 2008-2012 time frame, using 1990 as a base year. This protocol (unsigned by the United States), along with actions taken by Sonoma County and all the cities within Sonoma County committing to reduce by 20 percent CO₂ emissions in their jurisdictions by 2010, provided the impetus for the SSV goal.

The goals in the Kyoto Protocol and adopted by Sonoma County and the cities within it do not take into consideration energy intensity, i.e., energy used per unit of GDP. This lack of normalization is the primary basis of the negative reaction to the Kyoto Treaty from the U.S., the largest contributor of GHG emissions in the world (approximately 20-25 percent of the total anthropogenic emissions).

³ The Dow Jones Sustainability Index (DJSI) is an example of socially responsible investing. It is comprised of the top ten percent of companies (leaders in sustainable development) in 68 industry groups in 21 countries. Contrary to the belief that such a group of investments inherently provide poorer returns, the DJSI outperformed the Dow Jones Global Index for the five year period ending August 2001. According to the Social Investment Forum, in 1999 there was more than \$2 trillion in assets under management in the U.S. in portfolios that use screens related to corporate social responsibility, including environmental performance. In 1995 the figure was \$639 billion, and in 1997 \$1.185 trillion. The 1999 portfolio amount accounts for nearly 13 percent of the \$16.3 trillion in investment assets under professional management in the U.S.

⁴ The dominant fossil fuels in an industrialized society are coal, fuel oil and its derivatives such as gasoline, diesel, aviation fuel, propane, and natural gas.

⁵ Source: *2003 Silicon Valley Environmental Index*. Supporting data for the *Index* indicate that 3.66 million tons of carbon emissions occurred in 1990. Using the molecular weights of carbon (12) and carbon dioxide (44), 3.66 million tons of carbon is equivalent to 13.42 million tons of CO₂. Santa Clara County is used as a proxy for Silicon Valley by SSV and Silicon Valley Environmental Partnership (SVEP).

⁶ Anthropogenic emissions of CO₂ into the atmosphere are caused primarily by the combustion of fossil fuels such as coal, petroleum and its derivatives, and natural gas. In Silicon Valley these emissions are caused directly by (a) burning natural gas, (b) a relatively small amount of coal, and (c) petroleum-based products such as gasoline, diesel, jet fuel, and indirectly by using electricity, a portion of which is generated using fossil fuels. In 2000, approximately 55 percent of the CO₂ emissions in Silicon Valley came from burning gasoline, 18 percent from burning natural gas and 27 percent from electricity use. (Source: *2003 Silicon Valley Environmental Index*; diesel fuel sales are not available on a county-wide basis and therefore not included in SVEP's calculations of carbon emissions; jet fuel and coal are excluded from the SVEP analysis for a variety of reasons.)

There are two ways to reduce CO₂ emissions; reduce the amount of energy used and switch from fossil-based to non-fossil-based fuels. While the use of solar and wind energy to replace fossil fuel is justifiably held up as a poster child for the energy future, a fundamental step before deploying such renewable technologies is to increase energy efficiency. Studies consistently show that energy efficiency can be improved significantly, while generating

positive financial returns. SSV expects that most participants in this effort will meet the majority (if not all) of their CO₂ emissions reductions through cost-effective energy efficiency investments in both their stationary and mobile use of energy. Some fuel switching may be appropriate and necessary, especially in the mobile use of energy, e.g., the use of hybrid engines or converting fleets from diesel and gasoline to natural gas.

⁷ Those that have studied the California economy since the mid-1970s have concluded otherwise. Economic growth can and does occur in an environment of improving energy efficiency. See for example the California Energy Commission's *Inventory of California Greenhouse Gas Emissions and Sinks: 1990-1999* (http://www.energy.ca.gov/reports/600-02-001F/2002-09-14_600-02-001F.PDF).

⁸ Source: *2003 Silicon Valley Environmental Index*. Supporting data for the *Index* indicate annual tons of carbon emissions. Using the molecular weights of carbon (12) and carbon dioxide (44), tons of carbon is converted to tons of CO₂. Santa Clara County is used as a proxy for Silicon Valley by SSV and Silicon Valley Environmental Partnership (SVEP).

⁹ The greenhouse gases addressed by the Kyoto Protocol are CO₂, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride

¹⁰ The California Climate Action Registry (CCAR) is a nonprofit organization that was established by the State of California; the State has promised to protect the early actions of companies registering their annual GHG emissions, in the event of any future regulatory scheme. Companies can adopt any year from 1990 forward as a baseline year for their emissions. The CCAR Protocol requires reporting of direct and indirect GHG emissions addressed in the Kyoto Protocol, including CO₂. Any company registering its GHG emissions with CCAR will be in an excellent position to report to the SSV since reporting requirements under the CCAR protocol are more inclusive than those established by SSV, i.e., a company reports all its (Kyoto Protocol) GHG emissions to the CCAR, the Protocol includes direct and indirect emissions and requires entity-wide emissions reporting (the option exists to record data at the facility level so that if a company wished, it could download data for Silicon Valley facilities only). The CCAR Protocol requires reporting of vehicle usage for company-owned vehicles only; reporting employee travel/commuting is optional. The CCAR Protocol, along with CCAR's web-based reporting tool provide detailed instructions on inventorying GHG emissions; no specific metrics are proposed, although an organization may include these in their annual reports, which when certified, will be available on the Registry website.

¹¹ A number of measures could be used. One way of doing this would be for the participating organization to survey its employees annually to determine their mode of commuting to work. If the commute mode is automobile, other information should be ascertained, such as the average fuel economy (miles/gallon) of the vehicle (or type of automobile, e.g., subcompact, compact...SUV), number of miles driven per week, number of people in the vehicle, and other relevant information. With this information the average gasoline usage (gallons) can be determined. Additionally, CCAR works closely with the California Air Resources Board to ensure that emission factors are as up-to-date as possible and participants in the Silicon Valley challenge can access these factors through CCAR's Protocol and its regular updates.

¹² Diesel: 130,500 Btu/gallon (source: http://bioenergy.ornl.gov/papers/misc/energy_conv.html)
44.0 pounds Carbon per MMBtu (source: http://www.energy.ca.gov/reports/600-02-001F/2002-09-14_600-02-001F.PDF). 44/12 = molecular weight of CO₂/C.
Calculation: 44/12*44.0*0.1305 = 21.054 lbs CO₂/gallon (or 5.742 lbs C/gallon)

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